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nor is it ever diminished or changed in the slightest degree.

Moreover, according to the current conception, a changing species would commonly be modified into only one other form, or at best become split into two different types, separated from one another by flowering at different seasons, or by some other evident means of isolation. My evening primrose, however, produces in the same locality, and at the same time, from the same group of plants, quite a number of new forms, diverging from their prototype in different directions.

Thence we must conclude that new species are produced sideways by other forms, and that this change only affects the product, and not the producer. The same original form can in this way give birth to numerous others, and this single fact at once gives an explanation of all those cases in which species comprise numbers of subspecies, or genera large series of nearly allied forms. Numerous other distinct features of our prevailing classification may find on the same ground an easy and quite natural explanation.

To my mind, however, the real significance of the new facts is not to be found in the substitution of a new conception for the now prevailing ideas; it lies in the new ways which it opens for scientific research. The origin of species is no longer to be considered as something beyond our experience. It reaches within the limits of direct observation and experiment. Its only real difficulty is the rarity of its occurrence; but this, of course, may be overcome by persevering research. Mutability is manifestly an exceptional state of things if compared with the ordinary constancy. But it must occur in nature here and there, and probably even in our immediate vicinity. It has only to be sought for, and as soon as this is done on a sufficiently large scale

the study of the origin of species will become an experimental science.

New lines of work and new prospects will then be opened, and the application of new discoveries and new laws on forage crops and industrial plants will largely reward the patience and perseverance required by the present initial scientific studies.

HUGO DE VRIES.

SCIENTIFIC BOOKS.

The Direction of Hair in Animals and Man.

By WALTER KIDD, M.D., F.Z.S. London, Adam and Charles Black. 1903.

Dr. Kidd's recent work on the 'Direction of Hair in Animals and Man' is to a certain extent a compilation of his numerous previous works on the same general topic, to which is added a considerable amount of theoretical discussion. It is not intended to be an exhaustive treatment of the subject, but rather a discussion of those particular conditions which seem to substantiate the doctrines of Lamarck.

Three principles governing hair direction are pointed out:

1. That the simple and uniform hair slope of primitive mammals (*i. e.*, a general slope from cephalic toward caudal extremity of the body and from the proximal toward the distal end of the limbs) is not easily departed from in the individual development of any animal.

2. That there are certain modifications in this primitive arrangement that are due to morphological changes in the animal exhibiting them.

3. That all of the remaining phenomena of hair direction are to be explained by the action of mechanical forces on the surface of the body.

The first of these principles receives a brief discussion in which it is stated that the primitive hair slope corresponds to the direction of overlapping of the scales, which it is assumed covered the bodies of the earliest mammals. This law accounts for the slope of the major part of the hairy covering of any mammal. The existence of such a condition is

considered an adaptation and is attributed to natural selection.

The second law receives little explanation or discussion aside from a few illustrations.

It is upon the third law that the attention of the author is concentrated, since, obviously, the facts from which this law is deduced have direct bearing upon Lamarckism.

Those regions of the body of a mammal which are peculiarly open to contact with opposing surfaces or are under the special influence of certain active habits of a particular animal form are designated as 'critical areas.' They are the regions in which the action of the third law may be seen and they exhibit, to a greater or less extent, deviations from the primitive hair arrangement. Of such areas there are eleven, enumerated as follows: 'the naso-frontal, pectoral, cervical, axillary (post-humeral), inguinal, spinal, extensor surface of the ulna, ventral and lateral surfaces of the abdomen, extensor surface of the thigh, gluteal, and the side of the flank.' The deviations from the primitive hair slope which occur upon these areas are classified as (1) reversed areas of hair, (2) whorls, featherings and crests, (3) tufts.

A reversal involves a distinct opposition to the primitive hair direction and is attributed to the effect of contact with the ground or with other external opposing surfaces. Reversal is seen on the snout of the lion, for example, and over a still greater area on the nasal region of the horse and its allies. In these cases the hair, instead of sloping in the supposed primitive direction from the tip of the snout toward the top of the head, as illustrated by the red deer, slopes *toward the snout* from a point below the level of the eyes in the lion and between the eyes in the horse. This peculiarity of hair direction is explained as correlated with the angle at which the head is carried, and is attributed to the fact that air and other agents with which the face comes in contact oppose the primitive hair slope by stroking the hair toward the tip of the nose.

Most mammals spend a large proportion of their time in resting, and to the various positions employed much of the reversal of hair

direction is due. This contact with the ground or with some portion of the body in the habitual sitting or recumbent position accounts for reversals upon: (1) the pectoral region of practically all mammals except ungulates, (2) the extensor surface of the ulna in carnivores, certain ungulates and primates, including man, (3) the lateral aspect of the abdomen in nearly all carnivores and ungulates, and (4) the extensor surface of the thigh in many species. As the reversed hair direction upon the extensor surface of the ulna in man has hitherto been considered an important vestigial character, this new explanation of it is of especial interest.

The second named deviation from the primitive hair direction, viz., the whorl, involves the divergence of hair from a point and may be accompanied by the phenomenon of a feathering. In those cases in which the feathering occurs two divergent hair streams lead from the whorl, curve on each side into the general hair direction of the region and often terminate sharply by a crest or ridge where the opposing hair stream is met. Whorls and their attendant phenomena are attributed by Kidd to 'strong, very frequent, divergent muscular action' in the region over which the whorl occurs; but, although he shows in numerous cases an extremely interesting correspondence between the location of the whorl, feathering and crest, and the divergent arrangement of the underlying muscles, he unfortunately omits to explain the mechanical process by which such divergent muscular action could affect hair direction. We naturally infer that the force exerted is applied to the hair follicle, but if this is the case, and it could hardly be otherwise, the effect of the pull would be to turn the external portion of the shaft, not in the same, but in the opposite direction. It is thus somewhat difficult to see how the action of divergent forces upon the follicles could result in the divergence of the external portions of the hairs, *i. e.*, in the formation of a whorl.

The most abundant illustrations of the whorl are drawn from the domestic horse, the highly developed locomotive habits of which render certain regions exceedingly subject to

very frequent, strong, opposing muscular tractions. In both the frontal and pectoral regions of the horse the whorl is said to be absolutely constant, and in the latter region it is accompanied by a feathering and crest, thus involving a reversal of the hair over a portion of the pectoral area. In other mammals, even those so closely related to the horse as the mule and ass, pectoral whorls are of much less frequent occurrence. The cervical, axillary and inguinal regions of the horse show whorls with a greater or less degree of constancy, and statistics indicate a correspondence between the development of locomotive power, on the one hand, and both the degree of perfection and the constancy of occurrence of these whorls, on the other, a correspondence the significance of which is of course emphasized by their infrequent occurrence in related forms of less highly developed locomotive power. Thus Kidd looks upon these whorls as actual 'pedometers,' and by way of emphasizing their significance draws a striking comparison between the horse and the zebra, which rarely exhibits any whorls. "These two animals carry about on their hairy coverings indubitable records of their habits and those of their near ancestors."

To the action of the *panniculus carnosus* of the back in shaking off flies and other insects are attributed the whorl and feathering which occur upon the spinal area of the lion, ox, giraffe and larger antelopes. Statistics are given to show the correlation of this phenomenon with a heavy mane and long tail, devices for removing insects from other regions.

In the gluteal region of some animals, particularly certain breeds of dogs, whorls are described which, contrary to the principles previously set forth in defining a whorl, are attributed to the *passive influence of external pressure* resulting from the frequently assumed sitting posture. In none of the cases which happen to have come under my own observation, however, does this feature involve a *divergence* of hair (the essential element of Kidd's whorl) the figure being distinctly a *convergent spiral* (in Voigt's terminology a 'convergierende Wirbel') corresponding more

closely, as is shown later, to Kidd's definition of a tuft. Moreover, the sitting position of dogs is, so far as I have observed it, a crouching upon the hind legs, often with the ischial prominences hardly in contact with the ground, the weight being borne mainly upon the tarsus and foot.

Tufts, which of all the critical area phenomena are the most rare, involve always a convergence of the hair towards a point. Among the cases cited are those of the rare gluteal tuft of the horse said to be caused by the friction of the kicking-strap, and the more common gluteal tuft of the domestic ox, attributed to the habit of flicking the tail for the purpose of removing flies. There seems to be a decided discrepancy between these illustrations, with their explanations, and the general statement (p. 22) that tufts are the result of 'frequent, converging muscular action.' Even the tufts which are mentioned as occurring in the inguinal region in horses, although attributed to the action of the great oblique muscle, are not shown to be due to *convergent* muscular action.

These two regions, viz., the gluteal and inguinal, are the only ones upon which Kidd has found tufts. He has, however, overlooked several others of common occurrence, both on the horse and on other domestic animals. Such, for example, is the very common olecranal tuft which is well shown by short-haired dogs and is of practically constant occurrence in the human fetus.

A separate chapter is devoted to the consideration of the critical areas of man because man is the species the habits of which are the most completely known. Kidd finds *none of the peculiarities of hair direction in man dependent upon locomotive activity*. The numerous deviations from the primitive hair direction are, therefore, attributed not to motor phenomena, but rather to the influence of external forces.

The very ancient habit of sleeping or resting upon the back or side with the head and shoulders slightly elevated upon some sort of pillow is said to be responsible for many of man's peculiarities of hair direction. Among these are the partial reversal upon the deltoid

region and upon the lateral regions of the upper portion of the back, conditions found in no other species. These results are attributed to the tendency of the body to slide down from the pillow. The distinct lines of parting along the sides of the body on the ventral surface are thought to be possibly attributable to the pressure of the arm as it rests upon the body in sleeping, while the whorl which frequently occurs in this line is, contrary to the general principle earlier set forth as accounting for whorls, attributed to the pressure of the elbow.

The various methods of dressing the hair are said to account for the considerable variety of hair directions on the front of the scalp and the back of the neck.

The pressure of the clothing over the chest involved in respiratory movements is brought in to explain the reversal of hair above the 'sternal angle,' while the sudden diminution of hair at the level of the tops of the shoes is cited as an illustration of disuse and is attributed to the constant pressure of the shoe below that level.

In spite of the fact that the habits of man are so well known, it must be admitted that Kidd's discussion of the critical areas of man is the least complete and satisfactory portion of his book. Not only are some of the explanations submitted frankly given as mere conjectures, but many important phenomena are wholly ignored. For example, with the exception of the whorl upon the crown of the head, those which sometimes occur upon the lateral hair-parting of the trunk, and a pair in the pectoral region at the level of the sternal angle, there is no recognition of the many 'Wirbel' (Voigt's term) either divergent, *i. e.*, corresponding to Kidd's whorl, or convergent (Kidd's 'tufts') which have been so carefully worked out by Voigt and others and shown to be of such frequent, and in some regions of such constant occurrence upon the human body. Moreover, some of these phenomena correspond exactly in location to those to which Kidd attaches so much importance in his discussion of lower mammals. The axillary divergent Wirbel (a whorl), for example, has been found to be of practically

constant occurrence in man. Kidd, in discussing the axillary whorl of the horse, says (p. 39) that in this region 'the more passive influences of pressure on the hair or friction are not represented, but it is an area with considerable opportunity for the active influence of strong, divergent muscular action to manifest itself.' He adds: 'Whorls in this region are so rare outside of the ungulate order that after an extensive search for it in other hair-clad mammals, I have been only able to find two instances in which it was present, and then only in a rudimentary form.' The cases cited are both dogs.

This statement and the fact that Kidd attributes none of the peculiarities of hair direction of man to motor phenomena, show that he was probably unaware of the existence of this, and possibly also of many other whorls and tufts upon the body of man. If aware of their occurrence, then there is a serious and very unfortunate discrepancy in his explanations, since these two phenomena are in the early part of the book distinctly attributed to divergent and convergent action, respectively, of underlying muscles.

After the discussion of critical areas in lower animals and in man, Kidd gives by way of summary a chapter on the 'Delimitation of Hair Tracts.' These hair tracts are shown to be either (1) primitive or (2) acquired, (*a*) by morphological changes or (*b*) by use or habit. The whole primitive hair slope is compared to the course of a river which continues unchanged until some obstacle interferes with its accustomed flow. These obstacles in the case of the hair stream are the mechanical forces which act upon the growing hair opposing the primitive direction of growth. If the action is sufficiently constant the course of the stream is changed. Thus the hairy coat of a mammal bears an indubitable record of the forces to which it has been exposed.

The otter is cited as a form in which the hair tracts are wholly primitive, while the ox, horse and especially man show that with increasing complexity of form and habits of life come increasing mechanical disturbance of the primitive condition and consequent

increasing complexity of hair slope. With reference to man the statement is made that man has 'acquired, by some means or other, and transmitted, a very remarkable series of changes both from the primitive and from the Simian type.'

Those hair tracts which have been acquired by 'morphological changes' are described as merging somewhat into those acquired through the effect of use or habit (*i. e.*, mechanical forces), 'the frontiers between the two being, of course, somewhat vague.' In fact, there is no criterion whatever given by means of which one may know which deviations from the primitive direction are due to these 'morphological changes,' the whole distinction being, so far as I have been able to determine, a purely arbitrary one.

Kidd's theoretical discussion involves the following line of argument:

Deviations from the primitive direction of hair can not, even in the case of long-haired forms (with the single possible exception of the extensor surface of the ulna of certain of the Anthropoidea) be considered an adaptation. These deviations can, therefore, have no selective value and can not, like the primitive direction, be accounted for by any process of selection, natural, sexual or germinal.

The correlation between the deviations from the primitive direction and the mechanical forces exerted upon certain areas of the body indicates that these deviations are due wholly to such forces. Deviation from the primitive direction is, however, not easily produced and occurs only when there is a decided preponderance of force in a single direction.

The existence of these deviations in fetuses and in the new-born indicates their inheritance. Hence in the realm of hair direction the Lamarckian principle of the inheritance of acquired characteristics is established.

Kidd claims for his views no opposition whatever to Darwinism. On the contrary, his course of reasoning seeks to establish a fusion between the two great principles of natural selection and use-inheritance. The issue is, however, distinctly with Weismannism, which claims the non-inheritance of acquired characters as an integral part of its theory.

It is obvious that Kidd has laid before us a large number of extremely interesting facts showing an indisputable correlation between the direction of hair and the mechanical pressure from various causes, exerted upon the skin. His explanation of this correlation can, however, hardly be accepted as *final* at the present stage of the investigation, and the following criticisms are offered merely as suggestive of further research which the field demands:

1. There is no recognition in Kidd's discussion of a possible difference between the direction of the external portion of the hair and that of the follicle. Before any of the variations in hair direction upon the human scalp can, for example, be logically attributed to methods of parting and dressing the hair, it should be shown that a change in the direction of the external, more or less wiry portion of the hair produces a change in the direction of the follicle. In the case of the sloth, also, it is unquestionably a fact that in obedience to gravitation the long hair hangs down, in the habitual inverted position of the body. It would be exceedingly interesting, and, for the validity of Kidd's argument, of absolute importance to know (1) whether the follicles themselves have this same direction and (2) whether this direction occurs in the fetus. No one, indeed, will deny the temporary action upon hair of gravitation or any other external force which may be applied to it; but to show that these forces acting upon the long external hair produce any real change in the direction of the growing portion of the hair, which alone constitutes hair direction as used morphologically, is a necessary link in the chain of reasoning which seeks to prove that congenital hair direction of an animal can be attributed to mechanical forces acting upon the external portion of the hair of its ancestors.

The failure to recognize the possible difference between the superficial condition and the real hair direction may be further illustrated by Kidd's treatment of the mole. He says: "The skin of this animal possesses that unusual quality of hair resembling velvet and has no fixed slope of hair, as is the case in

most other animals, for the simple reason, it may be presumed, of its burrowing habits." I have found, however, in my own study of moles that if the hair is cut close to the body there is displayed in every region a decided hair slope, showing much individual variation and many whorls, tufts and other phenomena such as Kidd elsewhere considers important. Plainly here there is no correspondence between the external or apparent condition and the true hair direction. An equally careful examination of each long-haired form should be made before any definite statement as to its hair direction is given, since it is possible that even an animal exhibiting superficially the so-called primitive hair slope might show in the direction of the follicles unsuspected deviations from this.

2. Although one of the data with which Kidd prefaces his discussion is 'that the direction of hair can be modified in the life of an individual animal,' he gives no account of the actual observation of such changes. He says, "This is obviously the case in the head and face of man and may be assumed to be so in lower animals though not easily shown in particular cases." If this datum be true, however, and if the hairy coat of a horse is so exact a 'pedometer' as Kidd believes it to be, it should be easily possible during the training of a colt for the race-course and its subsequent career to observe actual changes of hair direction, and his conclusions will carry greater weight when such observations have been made. Unfortunately the few unconscious experiments which are cited as having been performed by man are largely negative in their results.

3. With regard to the inheritance of peculiarities of hair direction, much light would probably be thrown upon the subject by the study of conditions in several successive generations. In the case of rapidly breeding animals (*e. g.*, white rats, which I have found show much variation in hair directions of certain regions) such observations might easily be made, and in many cases three generations, at least, of the human species would be available.

4. As already indicated, there is no explana-

tion of the process by which the divergent traction of underlying muscles produces its supposed effect upon hair direction. The dynamic relation between such points of divergence and whorls is yet to be explained.

5. The very stronghold of Kidd's argument seems to be the assumed fact that practically none of the modifications of the primitive hair slope are adaptive. Is it not possible, however, that with a structure so complicated, so manifold in its functions, and, withal, at present so little known as the skin, even a short hairy covering may possess as yet imperfectly understood functions? Our present state of knowledge of this subject is, at least, not so complete that we are warranted in basing an argument upon the assumption of the lack of function of any particular hair direction.

Furthermore, even granting that a given hair direction is determined in response to mechanical causes, may not this very power of response on the part of the growing tissue be considered an adaptation and, therefore, of selective value?

On the other hand, ruling out any possibility of a selective process as accounting directly or indirectly for peculiarities of hair direction, Kidd fails to show any reason why these may not be simply spontaneous variations which, not held by a selective process to a definite course of evolution, are running riot, as it were. The very large amount of individual variation which Kidd himself acknowledges and which has been described by Voigt for the human species is itself an indication of the plausibility of such an explanation.

6. Kidd's treatment of the entire subject presents certain inconsistencies and discrepancies, some of which have already been pointed out. Probably the most serious of these is the lack of harmony between his preliminary statement of the cause of whorls and tufts as due to motor phenomena and his subsequent explanation of many of them as due to external pressure.

7. Perhaps the most serious fault of the whole work is the arbitrariness with which the lines are drawn distinguishing between the three principles governing hair direction.

With regard to the first of these, which assumes a primitive caudalward direction of the hair, it may be suggested that a careful study of the direction of the overlapping of scales not only in the few mammals in which these structures persist but in other scaly vertebrates, particularly reptiles, may show that the arrangement of scales upon which this primitive hair direction is based is not so simple a one as it is here assumed to be. My own investigation of this subject, the results of which I hope later to publish, has shown me that scale arrangement may involve points and lines both of convergence and of divergence.

With regard to the second principle, that of hair directions due to 'morphological changes,' I have already confessed an inability to understand what phenomena this principle accounts for or to determine upon what basis any particular modification of the 'primitive hair direction' would be ascribed to it. To be sure, the author says distinctly that he makes no attempt to discuss this principle. By omitting, however, to at least clearly define it he exposes himself to the criticism of having selected from the observed phenomena of hair direction those for which he could discover or conjecture a mechanical cause, and of having relegated to this nondescript class all other phenomena except those which are included under the supposed primitive direction.

It is, indeed, inconceivable that, provided mechanical forces can produce inheritable changes in hair direction, the hairy coat (or in fact, the scaly coat) of a mammal should at any stage of its evolution have been free from the influence of such mechanical forces. In other words, to explain a primitive hair direction as to any less extent due to the action of mechanical forces than are the deviations from it is illogical. Thus while Kidd's classification of hair tracts is a useful one for purposes of discussion, to base such a classification upon a distinct difference in cause (*i. e.*, natural selection, morphological change and use inheritance) is to employ arbitrary distinctions.

We are indebted to Dr. Kidd for reviving an especially fine field, not so much for theoretical discussion as for scientific research which

should eventually yield many data for such discussion. What is particularly needed at present is not a selection of facts to prove Lamarckism, Darwinism, Weismannism or any other theory, but a laborious, careful, complete working out of the entire field of hair directions, in as many forms as possible, together with a study of scale arrangement and the relation of scales to hair, to determine, if possible, the primitive conditions. Science has no place for dogmatic statement, and no hypothesis, however satisfactory when considered in view of one set of facts, should be protected at the sacrifice of a knowledge of any other facts which research may bring to light. Every scientist will argue with Dr. Kidd that 'the scientific attitude is that of judging a large series of facts on their own merits, and according to the weight of evidence, even if it tend against a widely accepted hypothesis!'

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DISCUSSION AND CORRESPONDENCE.

ON CITING THE TYPES OF NEW GENERA.

It seems worth while to call attention to the desirability of formally transferring the species upon which new genera are based, when these species have been earlier described in other genera. It seems a very trifling matter, but a bibliographer has to cite what he finds in print, and that only; and as a result of the present practise of many zoologists, the actual combination of a new generic name with its type species often occurs, not at the place where the genus is proposed, but accidentally, as it were, in some other easily overlooked place. To illustrate my meaning, I may refer to a couple of very recent instances:

Gilbertella, Eigenmann, Smiths. Misc. Coll., Vol. 45, p. 147. (1903.)

"Type.—*Anacyrtus alatus*, Steind."

Dimmockia, Ashmead, Mem. Carnegie Mus., Vol. 1, p. 357. (1904.)

"Type.—*Eulophus incongruus*, Ashm."

It seems to me that the proper way would have been to write for the first, type, *Gilbertella alata* (*Anacyrtus alatus*, Steind.), and the